PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : D21F 3/00 — A1

(11) International Publication Number: **WO 97/13030**

(43) International Publication Date: 10 April 1997 (10.04.97)

(21) International Application Number: PCT/FI96/00496

(22) International Filing Date: 20 September 1996 (20.09.96)

(30) Priority Data:
954698 3 October 1995 (03.10.95) FI

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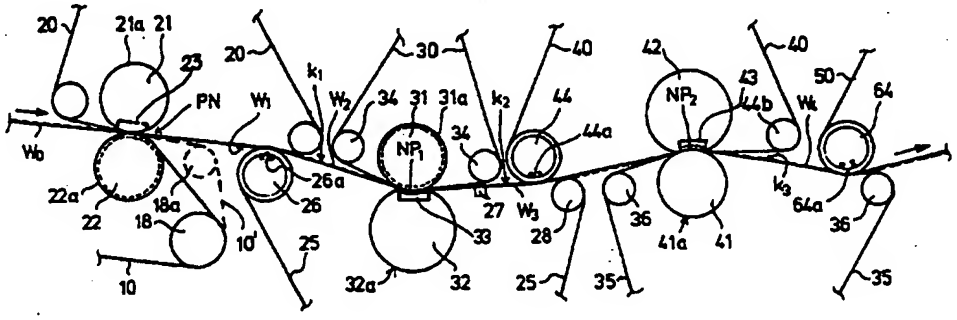
(81) Designated States: BR, CA, CN, JP, KR, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: METHOD AND DEVICE FOR REMOVAL OF WATER OUT OF A PAPER OR BOARD WEB BY PRESSING



(57) Abstract

The invention concerns a method and a device for removal of water out of a paper or board web and for passing said web as a closed draw from the forming wire (10; 10A) or transfer wire (10W) of the web former to the press section and through one or several dewatering press nips (N_1, NP_1, NP_2) in said press section. The web that runs on the forming wire (10; 10A) or on the transfer wire (10W) is made to adhere, in a transfer and pre-press zone (PN, PN_0, PN_{10}, PN_{00}, PN_1, PN_2), to the outside face of a transfer belt (20; 20A; 20B) substantially not receiving water. After this pre-press zone, the web is separated substantially immediately from said wire (10; 10A; 10W) and passed on support of the transfer-belt loop (20; 20A; 20B) onto the next press fabric in the press section and/or into the next press nip. In the pre-press zone or zones, a substantial amount of water is removed out of the web substantially in one direction only, and, at the same time, the web is made to adhere reliably to the outside face of the transfer-belt loop (20; 20A; 20B).

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Method and device for removal of water out of a paper or board web by pressing

The invention concerns a method for removal of water out of a paper or board web and for passing said web as a closed draw from the forming wire or transfer wire of the web former to the press section and through one or several dewatering press nips in said press section.

The invention also concerns a press section in a paper or board machine, comprising a number of successive press zones, the paper web being transferred into the first one of said press zones as a closed draw from the forming wire of the paper machine, and the paper web to be pressed being transferred between the different zones in said press section as a supported and closed draw, and the paper web being transferred, after the last press zone of said press zones, to the dryer section of the paper machine as a closed draw and a board web being transferred as a closed draw or as an open draw.

Increased running speeds of paper and board machines provide new problems to be solved, which problems are mostly related to the runnability of the machine. Currently speeds of up to about 1600 metres per minute are employed in paper machines. At these speeds the so-called closed press sections, which comprise a compact combination of press rolls fitted around a smooth-faced centre roll, as a rule, still operate satisfactorily. As examples of these press sections should be mentioned the applicant's Sym-Press II™ and Sym-Press O™ press sections.

Dewatering taking place by pressing is more advantageous than dewatering by evaporation, from the point of view of energy economy. This is why attempts should be made to remove a maximal amount of water out of the web by pressing, in order that the proportion of water to be removed by evaporation could be made as low as

possible. Increased running speeds of paper and board machines, however, provide new, so far unsolved problems expressly for dewatering taking place by pressing, because the press impulse cannot be increased sufficiently by the prior art means, above all because at high speeds the nip times remain insufficiently short and, on the other hand, the peak pressure of the compression cannot be increased beyond a certain limit without destroying the structure of the web.

With increasing running speeds of paper machines, the problems of runnability of a paper machine are also manifested with higher emphasis, because a web with a high water content and low strength does not endure an excessively high and sudden compression pressure impulse or the dynamic forces produced by high speeds, but web breaks and other disturbance in operation arise and cause standstills. In modern paper machines, the cost of standstill time is to-day about FIM 50,000 per hour.

Further drawbacks of the prior-art wire parts and press sections include the requirement of suction energy of the suction rolls commonly used in them and the noise problems arising from suction rolls. Moreover, suction rolls with their perforated mantles, inner suction boxes, wearing seals, and other suction arrangements are components of high cost which require repeated servicing and which consume an abundance of energy. As an example can be mentioned that in a board machine of a width of 6 metres the cost of suction energy of one suction roll is about 1 million FIM per year. In addition to the drawbacks mentioned above, the efficiency of the prior-art suction rolls is lowered significantly at particularly high web speeds, because the suction has not time to act upon the web in the intended way through the long perforations in the relatively thick mantle of the suction roll.

In the prior-art press sections, the web is, as a rule, passed from the forming wire into the first press nip on a pick-up felt, which also operates as a press fabric that receives water in the first press nip, which is either a roll nip or an extended nip. In the first press nip it is necessary to employ a relatively high compression pressure and to deal with large quantities of water, and it is one of the drawbacks arising from this that the outer face of the press felt tends to be contaminated and its porous

fibrous structure tends to be blocked partly. Attempts are made to prevent this by means of efficient felt conditioning devices, which are, however, quite expensive, spacious components which consume an abundance of energy.

Recently, even speeds as high as about 40 metres per second = 2400 metres per minute have been contemplated as speeds of printing-paper machines. Application of speeds as high as this, in particular in wide machines, provides ever more difficult problems to be solved, of which problems the most important ones are runnability and adequate dewatering capacity of the machine at a high web speed. Similarly, in board machines (basis weight of the web > 100 grams per square metre) attempts are made to increase the present web speeds (8...15 metres per second) to the level of 15...25 metres per second.

Important drawbacks of the press felts used in the prior-art press sections include the effect of rewetting the web and the tendency of contamination, because, in particular when said press felts run through a high-pressure nip or nips, particles of contaminations tend to be affixed and to adhere to the press fabrics, for which reason the operation of the press fabrics is disturbed and their cleaning requires efficient conditioning devices, which consume a considerable amount of energy.

Moreover, in high-pressure press nips, the prior-art porous press felts are subjected to intensive wear and strain, so that the felts must be replaced rather frequently, which increases the costs to a considerable extent.

Thus, the object of the present invention is to provide novel solutions for the problems discussed above so that the drawbacks in the prior-art mentioned above and the drawbacks that will come out later are substantially avoided.

The object of the present invention is to provide a method for removal of water out of a paper web by pressing at high speeds, in particular in the case of printing paper at speeds of about 25...40 metres per second, so that the quality properties of the web produced can be kept high and that no excessively high dynamic forces that

cause web breaks are applied to the web. Similarly, in board machines, owing to the present invention, attempts will be made to increase the web speeds to the speed range of 15...25 metres per second mentioned above.

Even though one of the principal objects of the present invention is to permit increased running speeds of both paper and board machines, this is not always an indispensable aim of the invention, but the advantages provided by the invention can, if necessary, be realized in paper and board machines that use current normal speeds also in the form of reduced consumption of energy by reducing the number of suction rolls, by eliminating the suction rolls, or by increasing the dry solids content of the web after the press section, in which case the proportion of dewatering taking place by evaporation can be reduced and, at the same time, the runnability and the efficiency of operation of the paper machine can be increased (fewer web breaks).

It is a non-indispensable further object of the invention to provide such a method and press section of the type concerned by whose means a paper or board can be produced whose surfaces have improved properties of smoothness.

With respect to the prior art most closely related to the present invention, the following is stated.

In board machines, a pre-press provided with a fabric circulation of its own has been employed, in which pre-press the linear load is for wires (so-called wire press) of an order of 15...20 kN/m and for press felts 40...50 kN/m. Experience of operation has been obtained from wire presses in particular with paper grades of a basis weight higher than 80 grams per sq.m. Moreover, several different presses operating by means of a pick-up suction roll have been in use, for example, in machines that produce kraft paper. With respect to these and to the rest of the prior art closely related to the present invention, reference is made to the applicant's *FI Patent Application No. 905798* and to the corresponding *EP Patent Application publ. No. 0487483 A1* and to the corresponding *US Patent No. 5,389,205*. In Figures 6A, 6B and 6C in said applications and in said US Patent, the use of a so-called wire press

nip is illustrated, by means of which wire press nip, fitted in connection with the web, the dry solids content of the web is supposed to be increased from about 10 % to about 20 %. Said wire nips are meant to be nips that remove water in two directions, either as a roll nip provided with two opposite press fabrics (Fig. 6A in said publications) or as an extended nip provided with an upper press felt (Fig. 6B), or as a belt-tensioned nip in which there is an upper press fabric (Fig. 6C). After said wire nips, the pre-pressed web is passed to the pick-up point, where it is transferred by means of the suction of the pick-up roll on the lower face of an upper pick-up press felt into the next nip, which is either an extended nip or a roll nip.

A wire nip arrangement substantially similar to that described above is also described in the *International Patent Application WO 9429519* (applicants Valmet-Tampella Inc.), to which publication reference is made in respect of the prior art.

In the prior art wire presses, it has, as a rule, been considered necessary that the dewatering takes place in the wire nips in two directions, i.e. also towards the upper press fabric. An exception from this consists of the what is called lump breakers, which are used in board machines in the way known from the prior art and which can also be used without a press fabric. As is known from the prior art, a lump breaker is placed in connection with a wire suction roll to form a wire nip, which increases the dry solids content of the web by just a few percentage units, and the primary function of this roll is to improve the upper surface properties of the board web and to facilitate the threading of the web. As a rule, as said lump breakers, a smooth roll provided with a resilient rubber coating is used, whose diameter is about 600...800 mm, and the linear load in said nip is maximally about 30 kN/m.

Further, with respect to the prior art related to the present invention, reference is made to the *EP Patent Application publ. No. 0359696 A2* of Beloit Corp., in which a roll nip placed in connection with a forming wire is described, which nip is provided with two press felts so that the lower press felt is fitted around a lower press roll inside the forming-wire loop and the upper press-suction roll is fitted inside the upper-felt loop. On said upper press-suction roll the web is transferred

from the forming wire onto the lower face of the water-receiving press felt and further as a horizontal run into the first extended nip, through which the upper press felt runs while it also operates as a press fabric in said nip. In the press sections mentioned above, even if objectives similar to those of the present invention are partly achieved in them, the press-suction roll can, however, not be eliminated, nor can rewetting of the web or the tendency of wear and contamination of the press felt be eliminated, which phenomena are particularly significant drawbacks expressly in a press section similar to that described in said EP publication 0359696.

In view of achieving the objectives stated above and those that will come out later and in order to avoid the problems mentioned above, the method in accordance with the invention is mainly characterized in that the web that runs on the forming wire or on the transfer wire is made to adhere, in a transfer and pre-press zone, to the outside face of a transfer belt substantially not receiving water, and that, after said pre-press zone, the web is separated substantially immediately from said wire and passed on support of said transfer-belt loop onto the next press fabric in the press section and/or into the next press nip.

The press section in accordance with the invention is mainly characterized in that the press section includes a pre-press zone or zones, that the press section includes a transfer-belt loop, which does substantially not receive water and whose outer face is capable of adhesion to the paper web, that said transfer-belt loop is passed through said pre-press zone or, out of two zones, at least through the latter zone, that in said pre-press zone the paper web is made to adhere to the outside face of the transfer-belt loop and, after said zone, is separated substantially immediately from the forming wire or equivalent without substantial rewetting of the web, and that, on said transfer belt, the web is passed as a closed and supported draw onto the next press fabric in the press section and/or through the next press zone.

In the present invention, a reliable and closed transfer of the web from the former section to the dryer section is accomplished without risk of rewetting of the web. Also, if necessary, in the invention, in connection with the forming wire or an

equivalent transfer wire it is possible to arrange one or several pre-press zones, on which the web is made to adhere reliably to the transfer belt substantially not receiving water, which belt is an essential component in the invention, and, moreover, a substantial amount of water is removed, which increases both the dry solids content and the wet strength of the web. This again improves the runnability of the press section and facilitates later stages of dewatering.

The transfer belt in accordance with the invention is not susceptible of wear and contamination to the same extent as a conventional porous press felt is, and, also, the transfer belt in accordance with the invention tolerates even efficient cleaning more readily, such as cleaning by means of high-pressure water jets or doctors.

In a preferred embodiment of the invention, in the pre-press and transfer zone, the dewatering takes place in one direction, preferably downwards, whereby the treatment and further draining of the relatively large quantities of water removed in the pre-press zone or zones are promoted.

By means of the method and press section of the present invention it is possible to achieve improved properties of smoothness of the faces of the paper or board produced, which is partly based on the use of a relatively smooth-faced transfer belt applied and arranged as per the invention in an appropriate process stage.

In the following, the invention will be described in detail with reference to some exemplifying embodiments of the invention illustrated in the figures in the accompanying drawing, the invention being by no means strictly confined to the details of said embodiments.

Figure 1 is a schematic side view of the wet end of a paper machine that makes use of a press section in accordance with the invention and of the connection of said wet end with the initial end of the dryer section.

Figure 2 shows an embodiment of a press section mainly intended for printing papers and fine papers.

Figure 3 shows a press section which is intended in particular for thicker paper grades and/or for particularly high-speed machines and in which there are three extended-nip zones besides a wire pre-press zone.

Figure 4 shows an embodiment of the invention in which the pre-press nip has been arranged after the former section as separate from the former section.

Figure 5 shows a former section of a board machine and a press section in accordance with the present invention fitted in connection with the former.

Figure 6 is an illustration similar to Fig. 5 of a board machine and of a second press section of same in accordance with the invention.

Figure 7 shows a press section in accordance with the invention which is mainly suitable for boards, in which press section there are two separate wire pre-press nips in connection with the forming wire.

Figure 8 shows a modification of Fig. 7 and an embodiment of a pre-press section provided with two separate wire press nips.

Figure 9 shows a two-nip pre-press section similar to those shown in Figs. 5 and 6.

Figure 10 shows a pre-press section in which there are a pre-press roll nip and a preceding belt-tensioned press zone in connection with a wire suction roll.

Figure 11 shows a modification of the press section shown in Fig. 10.

Figure 12 shows a modification of the invention in which an extended-nip zone arranged by means of a shoe press is used as a pre-press zone.

Figs. 1 to 4 illustrate press sections in accordance with the invention intended in particular for different paper grades, and Figs. 5 to 11 illustrate press sections mainly intended for boards (basis weight 100...400 grams per sq.m) and details of said press sections. However, it should be emphasized that many details of the press sections shown in Figs. 1 to 4 are also suitable for use with board, and the press sections shown in Figs. 5 to 11, at least some of them, are also suitable for use with different paper grades.

Fig. 1 is a schematic illustration of an exemplifying embodiment of the overall arrangement of a paper machine that makes use of a press section in accordance with the present invention. Fig. 1 shows the twin-wire gap former of the paper machine, in which former there is a lower wire 10 and an upper wire 15, the headbox 11 of the paper machine feeding a pulp suspension jet into the forming gap G defined by said wires. The forming gap G is defined between the runs of the wires 10,15 guided by the breast roll 12 of the lower wire 10 and by the forming suction roll 13 placed inside the upper-wire loop 15. In this exemplifying embodiment, the curved twin-wire forming zone placed on the forming roll 13 is first followed by a forming shoe 14 provided with a ribbed deck and after that by a second forming suction roll 16, on whose suction zone 16a the twin-wire zone is curved from upwards inclined to downwards inclined. After this, inside the lower-wire loop, there are suction boxes 17, of which the last box or boxes separate the web W_0 from the upper wire 15. After this the web W_0 follows the lower wire 10 as a downwards inclined run into the pre-press zone PN in accordance with the invention. After the twin-wire zone, the dry solids content of the web W_0 is, as a rule, of an order of $k_0 \approx 10$ %. In addition to the wet wire, i.e. the lower forming wire 10, an upper transfer belt 20 also runs through the pre-press zone PN, which belt has been arranged in accordance with the invention and which belt does substantially not receive water, so that in the pre-press zone PN the draining of water takes place primarily downwards through the forming wire 10, i.e. in the direction of the force of gravity, which facilitates the treatment and further draining of the large quantities of water to be removed in this zone. Moreover, the outer face of the transfer belt 20 is relatively smooth and even in other respects provided with such adhesion properties that the web W_1 is separ-

ated from the forming wire 10 substantially without rewetting immediately after the pre-press zone PN and runs on support of the transfer belt 20 substantially along a straight downwards inclined run.

In the pre-press zone PN, water is, as a rule, removed to such an extent that the dry solids content of the web $\Delta k = k_1 - k_0$ is increased by $\Delta k \approx 7...10$ percentage units. The linear load present in the pre-press zone PN is, as a rule, chosen in the range of 25...400 kN/m, preferably in the range of 40...250 kN/m.

From the transfer belt 20 the web W_1 is made to adhere to the lower press felt 25 on the suction zone 26a of the transfer suction roll 26. On the lower felt 25 the web W is transferred through the extended-nip zone NP_1 placed after the first pre-pressing substantially dewatering the web. The upper-felt loop 30 also runs through the extended-nip zone NP_1 so that, in the extended nip NP_1, the dewatering takes place in two directions through both faces of the web.

As is shown in Fig. 1, after the extended nip NP_1 the web W_2 is transferred from the lower felt 25 onto the upper felt 40 on the suction zone 44a of the transfer suction roll 44. On the lower face of the upper felt 40 the web W_2 is transferred through the second extended-nip zone NP_2. After the extended-nip zone NP_2 the web W_3 is made to adhere to the smooth-faced second transfer belt 35, which does preferably substantially not receive water, and the web is transferred on said belt onto the drying wire 60 on the suction zone 64a of the transfer suction roll 64. After this the web W_4, whose dry solids content is $k_4 \approx 42...55$ %, is passed over steam-heated drying cylinders 61. In the gaps between the drying cylinders 61 in the upper row there are reversing suction cylinders 62, which are provided with a hollow face 62a subjected to a vacuum. As is seen from Fig. 1, the run of the web from the former section to the dryer section is highly linear so that its largest angle of change in direction is smaller than about $d < 30°$. Moreover, from the former section to the drying wire 60 the web has a fully closed and supported draw, which has, moreover, been accomplished without a major risk of rewetting of the web.

In the following, different embodiments and features of construction of the end portion of the wire part and of the press section, which have been illustrated in Fig. 1 generally, will be described in more detail with reference to Figs. 2 to 4.

As is shown in Fig. 2, the pre-press zone PN has been formed between a press roll 21 provided with a smooth cylinder face 21a or an equivalent extended-nip roll, fitted inside the transfer-belt loop 20, and a lower roll. Said extended-nip roll alternative is illustrated in Fig. 2 by the press shoe 23A shown by dashed lines inside the roll 21. The lower roll in the pre-press zone PN, which roll is placed inside the loop of the forming wire 10, is a hollow-faced 22a press roll 22. In the position of this roll 22, in an exceptional case, there may also be a suction roll. In Fig. 2 the dashed line illustrates such a run 10' of the forming wire after the pre-press zone PN as is guided by a guide roll 18a. By means of this arrangement the transfer of the web W_1 onto the lower face of the transfer belt 20 is promoted. The drive roll of the forming wire 10 is denoted with the reference numeral 18.

As is shown in Fig. 2, the first press zone after the pre-press zone PN is an extended nip NP_1, through whose press zone two water-receiving press fabrics 25 and 30 run. The lower roll in the extended-nip zone NP_1 is a hose roll 32 provided with a press shoe 33, and the upper roll is a hollow-faced 31a press roll 31. The outside face of the hose mantle 32a of the roll 32 can be hollow-faced or smooth. In some cases the extended-nip zone NP_1 can be substituted for by a corresponding roll nip. After the extended-nip zone NP_1 the web W_3 has been arranged to follow the lower felt 25, which is guaranteed by means of a suction box 27. After the suction box 27 the dry solids content k_2 of the web is typically $k_2 \approx 32...47$ %, whereas, before the extended-nip zone NP_1, the dry solids content k_1 of the web W is typically $k_1 \approx 16...25$ %.

In Fig. 2 the web W_3 is separated from the lower fabric 25 on the suction zone 44a of the transfer suction roll 44, on which zone the web is transferred onto the upper fabric 40, which runs through the second extended-nip zone NP_2 as the upper fabric of said zone. The lower fabric in the second extended-nip zone NP_2 is preferably a

transfer belt 35 that does substantially not receive water, and owing to the surface properties of said belt the web W_4 is transferred, after the extended-nip zone NP_2, before the guide roll 44b of the upper felt 40, onto the drying wire 60 while aided by the vacuum present in the suction zone 64a of the transfer suction roll 64 placed inside the loop of said wire 60. After the second extended-nip zone NP_2 the dry solids content k_3 of the web W_4 is typically $k_3 \approx 42...55$ %. The upper roll 42 in the extended-nip zone NP_2 is a hose roll, in whose interior there is a pressure-loaded press shoe 43, and the lower roll is a smooth-faced or hollow-faced 41a press roll 41, which can be a variable-crown roll if necessary. In stead of an extended-nip zone NP_2, it is also possible to use a roll nip, and in stead of a transfer belt 35 it is possible to use a water-receiving press fabric, so that in the nip zone NP_2 the dewatering can also take place in two directions.

The press section shown in Fig. 3 differs from that shown in Fig. 2 in the respect that, in connection with the forming wire 10, there is no pre-press nip proper, but in connection with the suction zone 22b of the wire 10 suction roll 22 there is a web W_0 adhering nip PN_0 formed by a small-diameter press roll 21, in which nip the linear load is low, typically of an order of 15...40 kN/m. By means of the adhering nip PN_0 it is ensured that directly after the nip the web W_1 is separated from the forming wire 10 and follows the transfer belt 20 that does not receive water, on which belt 20 the web W_1 is passed into the first pre-press nip NP proper. As the pre-press nip PN an extended-nip zone is used, in which the lower roll 32 is a hose roll which is provided with a pressure-loaded press shoe 33. In the pre-press zone PN the lower fabric is a pre-press wire 25W, in stead of a press felt, which wire 25W has a relatively open and permeable fibre structure and which can be kept clean readily. The mantle of the hose roll 32 is preferably provided with a relatively open hollow face, such as grooves 32a. The upper roll in the pre-press zone PN is a hollow-faced 31a press roll 31, which can, if necessary, be a variable-crown roll provided with a press shoe 33 in view of control of the cross-direction compression-pressure profile. In respect of the extended-nip zones NP_1 and NP_2 placed after the pre-press zone PN, the construction is similar to that described above in relation to Fig. 2.

The embodiment of the invention shown in Fig. 4 differs from that shown in Fig. 3 in the respect that in Fig. 4, in connection with the forming wire 10 proper, there is no wire nip at all, but after the normal wire suction roll 19 provided with a suction zone 19a the web W_0 is transferred on the suction zone 24a of the pick-up roll 24 onto a pre-press wire 10W of a relatively open and permeable fibre structure, the web W_0 being transferred on the lower face of said wire into the first pre-press zone PN_{10} proper. Through this pre-press zone PN a lower transfer belt 20B runs, which does substantially not receive water. The upper roll in the pre-press zone PN is a hose roll 21, in which there is a pressure-loaded press shoe 23, and the lower roll 22 is a smooth-faced or hollow-faced 22a press roll. From the lower transfer belt 20B the web W_1 is transferred, on the suction zone 34a of the transfer suction roll 34, onto the upper felt 30, which operates as the upper fabric in the first extended-nip zone NP_1 after the pre-pressing. After the extended-nip zone NP_1 the web W_2 is transferred, aided by a suction box 27 if necessary, onto the lower fabric 35 and from it further onto the upper felt 40 on the suction zone 44a of the transfer suction roll 44. On the upper fabric 40 the web runs through the second extended-nip zone NP_2, after which the web W_4 is separated onto the transfer belt 45, on which it is passed onto the drying wire 60. If necessary, one or both of the extended nips NP_1 and NP_2 can be substituted for by a corresponding roll nip, and in stead of the transfer belt 45 it is possible to use a press felt substantially receiving water, and in stead of the press felt 35 it is possible to use a transfer belt not receiving water.

The embodiment of the invention shown in Fig. 4 is not in all respects as favourable as the embodiments shown in Figs. 1 to 3, because, when a pre-press and transfer wire 10W separate from the forming wire and a separate pre-press zone PN_{10} are used, the overall length of the press section is increased and, moreover, it is necessary to use a pick-up suction roll 24, but, yet, the use of a pick-up felt proper and the drawbacks arising from it, such as tendency of contamination, are avoided.

Fig. 5 shows, by way of example, an embodiment of a press section in accordance with the invention in connection with a board machine and with its multi-layer web former. As is shown in Fig. 5, the web former of the board machine comprises a

lower wire 10A, onto which the headbox 11A feeds a pulp suspension jet. After the slice part of the headbox 11A there follows a horizontal fourdrinier wire part, in which there is first a forming board 13A followed by wet suction boxes 14A. The component web W_A thus partially formed is combined with a component web W_B formed by means of the upper-wire unit. The upper-wire unit comprises a headbox 11B, which feeds a pulp suspension jet onto the upper wire 15B. On the horizontal initial portion of the upper wire 15B there is first a forming board 13B, which is followed by wet suction boxes 14B. The component webs W_A and W_B are combined into a combination web W_{AB}, which is passed on the lower wire 10A over the dry suction boxes 17A into the press section in accordance with the invention. After the dry suction boxes 17A the web W_{AB} is passed on the lower wire 10A through two pre-press nips PN_1 and PN_2 in accordance with the invention. The lower roll of these pre-wire-press nips PN_1 and PN_2 is a press roll 22, which is placed inside the lower-wire loop 10A and which has an open hollow outer face 22a that receives water, possibly provided with a shrink-wire sock. In accordance with the invention, a transfer belt 20 that does substantially not receive water has been arranged to run through the pre-press zones PN_1 and PN_2, which belt transfers the board web into the first press nip N_1 proper. The nip N_1 is a roll nip, whose nip zone has been extended by using press rolls 31 and 32 of relatively large diameters. Of the press rolls, the upper roll 31 is a smooth-faced 31a press roll, and the lower roll is a press roll provided with an open hollow face 32a. Through the nip N_1 a relatively thick lower felt 25 runs which receives an abundance of water. In the nip N_1 the de-watering takes place in one direction, as it does in the pre-press nips PN_1 and PN_2, because the transfer belt 20 does substantially not receive water. After the nip N_1 the board web follows the transfer belt 20, based on its adhesion properties, after which the board web is transferred onto the second lower felt 35, which carries the board web through the extended-nip zone NP_2. Through the extended-nip zone NP_2, said lower felt 35 and the water-receiving upper felt 40 run. The upper roll in the extended-nip zone NP_2 is a hollow-faced press roll 41, and the lower roll is a hose roll 42, in which there is a pressure-loaded press shoe 43. After the nip zone NP_2 the board web is passed as an open draw W_F onto the drying wire 60. The open draw W_F is possible, because, owing to efficient dewatering, the board web is of

sufficiently high strength after the nip NP_2 in view of prevention of web breaks. On the drying wire 60 the board web is passed over the contact drying cylinders 61 and reversing suction cylinders 62.

Fig. 5 schematically shows belt conditioning devices 70 in connection with the transfer belt 20, by means of which devices 70 the outer face of the transfer belt 20 is kept clean. The devices 70 can include doctors, high-pressure water jets and/or other, equivalent conditioning devices in themselves known, which are placed in different locations along the circulation of the transfer belt loop 20. Owing to the non-porous structure substantially not receiving water and to the smooth face of the transfer belt 20;20A;20B, the transfer belt tolerates even a high press-nip loading and even highly efficient cleaning substantially better than corresponding porous press felts do. Devices similar to the conditioning devices 70 are provided in all the embodiments of the belt circulations illustrated in the figures, in which illustrations the devices 70 are, yet, not shown or described to avoid unnecessary repetition.

Fig. 6 shows an alternative embodiment of a press section in accordance with the invention for a board machine. In respect of the multi-layer web former 10A...17A, 11B...15B and of the pre-press zones PN_1 and PN_2 the construction is similar to that shown in Fig. 5. Unlike Fig. 5, in the press section of Fig. 6 there is just one press nip proper, i.e. the extended nip NP_1, through which said transfer belt 20 runs. The lower fabric in the extended nip NP_1 is a press felt 25 which receives a large amount of water and which has a relatively high basis weight, preferably about 1500...2000 grams per sq.m. After the extended-nip zone NP_1 the board web follows the transfer belt 20 on the basis of its adhesion properties, and the board web is transferred onto the transfer fabric 35 by the effect of the vacuum in the suction zone 34a of the transfer suction roll 34. Inside the loop of the fabric 35, a lead-in cylinder 61A is fitted, on whose turning sector the board web is transferred from the fabric 35 onto the drying wire 60.

Fig. 7 shows an alternative embodiment (in particular meant for board) for embodiments of wire press nips in a press section in accordance with the invention. As is

shown in Fig. 7, the web W_0, which may also be a paper web, is brought into the first pre-wire nip PN_{00}. The lower roll 21A in this nip PN_{00} is a solid-mantle roll (hardness ~ 100...150 P&J), and the upper roll 21B is a roll with an open face, which is coated, for example, with a wire sock. Into the pre-wire nip PN_{00}, in addition to the forming wire 10;10A, an upper press wire 10c has been passed, which is guided by guide and tensioning rolls 23A. In the pre-wire nip PN_{00} the dry solids content of the web W_0, which is typically $k_0 \approx 12...18$ %, is raised to the level of $k_{10} \approx 16...22$ %. After the pre-wire nip PN_{00} the web W_1 follows the forming wire 10;10A into the second transfer and pre-press zone PN, which has been arranged between the wire turning roll 22 fitted inside the forming-wire loop 10;10A and provided with an open face 22a and the press roll 21 fitted inside the transfer-belt loop 20. The line pressure present in the first pre-wire nip PN_{00} is maximally of an order of ~ 70 kN/m and in the pre-press nip PN proper maximally of an order of ~ 100 kN/m. As the smooth-faced roll 21 in the pre-press nip PN proper, preferably a rubber-coated roll is used whose surface hardness is of an order of ~ 50 P&J. On the transfer belt 20 the web W_2 is transferred onto the lower felt 25 with the aid of the suction zone 26a of the suction transfer roll 26. Unlike Figs. 5 and 6, in Fig. 7 the transfer belt 20 does not run through the other press zones except through the pre-press zone PN proper. On the lower felt 25 the web W_2 is transferred into the next press nip (not shown). The press section placed after the pre-press section as shown in Fig. 7 can be accomplished by means of one or several roll nip(s) and/or extended nip(s), for example by making use of press and web-transfer arrangements substantially similar to those illustrated above in Figs. 1...6.

Fig. 8 shows a pre-press arrangement in which the paper or board web W_0 is brought on the forming wire 10;10A over the dry suction boxes 17A into the first pre-press zone PN_{01}, which has been formed between the upper roll 21A and the lower roll 22. The upper roll 21A is a smooth-faced 21a press roll (hardness 100...150 P&J), and the lower roll 22 is an open-faced 22a roll, for example a roll coated with a wire sock or a grooved roll. As the lower roll 22, it is also possible to use a suction roll, whose suction zone extends over the nip PN_{01}. This suction zone does, however, not extend to the area of the pre-press nip PN proper, whereby

the transfer of the web W_1 onto the transfer belt 20 is ensured. In the pre-press nip PN_{01} the press load is maximally of an order of ~ 70 kN/m. It is a particular feature, differing from the above, of the first pre-press nip PN_{01} shown in Fig. 8 that the forming wire 10;10A only passes through this press zone. After the nip PN_{01} the web W_1 follows the forming wire 10;10A, on which it is passed into the second pre-press nip PN proper. Through the nip PN the transfer felt 20 runs, which has been arranged in accordance with the invention and which does substantially not receive water. After the nip PN the web W_2 is directly detached and separated from the forming wire 10;10A and transferred on the face of the transfer belt 20, based on its adhesion properties, onto the first lower felt 25 of the press section. The press roll 21B of the pre-press nip PN, placed inside the transfer belt 20, is a solid-mantle 21b press roll. In the pre-press nip PN a linear load of maximally about 100 kN/m is employed. A backup roll common of the pre-press nips PN_{01} and PN is a press roll 22 of relatively large diameter, which is provided with an open face 22a and which has no suction.

The press section shown in Fig. 9 differs from that shown in Fig. 8 in the respect that, being guided by guide and tensioning rolls 23, the transfer belt 20 has been arranged to pass through two pre-press zones PN_1 and PN_2. The upper roll 21A in the first pre-press zone PN_1 is a solid-mantle roll which is provided with a resilient, for example, rubber coating 21a and whose hardness is of an order of ~ 100...150 P&J. The upper roll 21B in the latter pre-press zone PN_2 is a solid-mantle 21b roll which is provided with a resilient, for example, rubber coating and whose hardness is of an order of ~ 50 P&J. In the first pre-press zone PN_1 a line pressure of maximally about 70 kN/m is employed, and in the latter press zone PN_2 a line pressure of maximally about 100 kN/m. After the latter pre-press zone PN_2 the web W_2 is transferred on the lower face of the transfer belt 20 onto the first lower press felt 25 by means of the suction zone 26a of the transfer suction roll 26. After this the press section can be substantially similar to Figs. 1...7 described above.

As is shown in Figs. 10 and 11, the pulp web W_0 arriving on the forming wire 10;10A is passed after the wet suction boxes 16A to under a transfer belt 20A

substantially not receiving water. Between the parallel joint runs of the transfer belt 20A and the forming wire 10;10A, the pulp web W_0 runs over a group of dry suction boxes 17A, in which connection the transfer belt 20A intensifies the suction effect of the dry suction boxes 17A. After this the forming wire 10;10A and the transfer belt 20A are curved over the sector a over the suction zones 22aa and 22bb of the wire suction roll 22. In the press zone of this sector a, whose magnitude is preferably $a \approx 25°...80°$, water is drained out of the web W_0 downwards through the forming wire 10;10A by the effect of suction and partly by the effect of the tensioning pressure $P = T/R$ of the transfer belt 20A, wherein T is the tightening tension (N/m) of the transfer belt and R is the radius of the transfer suction roll 22. The belt-tension-pressured press zone PT is followed by a pre-press and transfer nip PN, which is formed between said wire suction roll 22 and a press roll 21 provided with a smooth, resilient if necessary, outer mantle 21a. In this pre-press nip PN considerable amounts of water are transferred with the aid of the vacuum in the latter suction zone 22bb of the transfer suction roll 22 further through the forming wire 10;10A in one direction and downwards, i.e. in the direction of the force of gravity. In the pre-press nip PN the web W_0 is also made to adhere to the smooth lower face of the transfer belt 20A and is passed on the transfer belt 20A onto the lower press felt 25, to which the web is made to adhere by means of a suction roll 26 (Fig. 10) or by means of a suction box 26A (Fig. 11). From the lower felt 25 or equivalent transfer belt the web W_1 is transferred after the reversing roll 34 onto the upper fabric 30.

In the way shown in Fig. 12, in connection with the open-faced 22a roll 22 placed inside the loop of the forming wire 10;10A, a pre-press zone PN in accordance with the invention has been formed by means of a press shoe 23B. The press shoe 23B forms an extended-nip zone in connection with the roll 22, through which zone the transfer belt 20 runs guided by the guide rolls 24b and 24c. On the transfer belt 20 the paper web W is passed through the extended-nip zone NP_1. The construction of the extended-nip zone NP_1 is similar, for example, to the extended-nip zone NP_1 shown in Fig. 2. After the extended-nip zone NP_1 the paper web W is separated from the lower felt 25, and the web W follows the transfer belt 20 onto the suction

zone 64a of the suction roll 64 of the drying wire 50, on which zone 64a the web W is transferred onto the drying wire 50. By means of the pre-press zone as shown in Fig. 12 as well as by means of the pre-press zones described above, it is possible to eliminate destruction of the web structure by increasing the compression pressure in the pre-press zone PN gradually. When a press shoe 23B is employed, it is also possible to avoid generation of heat in soft pre-press rolls.

In the present invention an essential component is a transfer belt 20;20A;20B, which does substantially not receive water and which has been arranged in the way described above. It is characteristic of this transfer belt 20;20A;20B that it is substantially impenetrable, i.e. either does not receive water at all or receives water to a slight extent only. A further important feature is the capability of adhesion of the transfer belt 20;20A;20B, so that it is capable of directly separating the web after a pre-press zone or equivalent without risk of rewetting. This adhesion capacity is partly based on the smooth or substantially smooth outer face of the transfer belt and on the choice of its materials. The transfer belt 20;20A;20B is substantially non-stretching. As the material of the transfer belt 20;20A;20B it is possible to use various synthetic materials, and it can be provided with metal, composite and/or fabric reinforcements. The thickness of the transfer belt 20;20A;20B is, as a rule, dimensioned in the range of 1...5 mm, so that it endures bending, the compression pressures in the various nips, doctoring, and cleaning with high-pressure water jets.

It is an essential feature of the operation of the transfer belt 20;20A;20B arranged in accordance with the invention that, as the transfer belt 20;20A runs through a pre-press and transfer nip, besides a considerable drainage of water, it is also achieved that, owing to the compression pressure, at the same time the web adheres reliably to the outer face of the transfer belt 20,20B, which contributes to a reliable and direct transfer of the web onto the next press fabric or into the next press nip after the pre-press zone without rewetting and as a closed draw without risk of breaks.

If necessary, the press section in accordance with the invention can be provided with regulations of the profiles of the press nip pressures in the machine direction and in

the cross direction in compliance with the principles that are described in the applicant's *FI Patent Application No. 905798* (corresponding *EP publication No. 0487483 A1* and *US Patent No. 5,389,205*) mentioned in the preamble part of the present specification. The regulations of these profiles can be carried out in a way in itself known, for example by regulation of the compression pressure profiles of the press shoes 33,43 in the extended-nip hose rolls 32,42 and/or by regulation of the deflection of the backup rolls 31;41 in the extended nips NP_1,NP_2. By means of these regulations of profiles, it is possible to control the profiles of the paper produced both in the machine direction and in the cross direction, which profiles are important in view of the quality properties of the paper.

In the following, the patent claims will be given, and the various details of the invention can show variation within the scope of the inventive idea defined in said claims and differ from what has been stated above by way of example only.

Claims

1. A method for removal of water out of a paper or board web and for passing said web as a closed draw from the forming wire (10;10A) or transfer wire (10W) of the web former to the press section and through one or several dewatering press nips (N_1,NP_1,NP_2) in said press section, **characterized** in that the web that runs on the forming wire (10;10A) or on the transfer wire (10W) is made to adhere, in a transfer and pre-press zone (PN,PN_0,PN_{10},PN_{00},PN_1,PN_2), to the outside face of a transfer belt (20;20A;20B) substantially not receiving water, and that, after said pre-press zone, the web is separated substantially immediately from said wire (10;10A; 10W) and passed on support of said transfer-belt loop (20;20A;20B) onto the next press fabric in the press section and/or into the next press nip.

2. A method as claimed in claim 1, **characterized** in that in the pre-press zone or zones, a substantial amount of water is removed from the web primarily in one direction only, preferably downwards, and that, at the same time, the web is made to adhere reliably to the outer face of the transfer-belt loop (20;20A;20B).

3. A method as claimed in claim 2, **characterized** in that in said pre-press zone or zones, water is removed out of the web to such an extent that the dry solids content of the web is increased by about 2...12 percentage units, preferably about 4...8 percentage units.

4. A method as claimed in claim 1, **characterized** in that, on the forming wire (10;10A), a web adhering nip (PN_0) is arranged, in which a relatively low line pressure is employed, which pressure is preferably chosen in the range of 15...40 kN/m, that through said adhering nip (PN_0) a transfer belt (20) is passed, on which the paper web (W_1) is transferred into a separate pre-press zone (PN) placed after the web former section, through which pre-press zone (PN) a permeable pre-press wire (25W) passes as the lower fabric, and that, after said pre-press zone (PN), the web is transferred on said transfer belt (20) onto the next press fabric in the press section (Fig. 3).

5. A method as claimed in claim 1, **characterized** in that the web is transferred from the forming wire (10) on the suction zone (24a) of a pick-up roll (24) or equivalent onto a pre-press wire (10W) of relatively open and permeable fabric structure, the web (W_0) being passed on the lower face of said wire (10W) into the first pre-press zone (PN_{10}) proper, through which zone, from below, a transfer belt (20B) substantially not receiving water runs, and that the paper web (W_1) is passed on said transfer belt (20B) as a closed draw onto the upper press fabric (30) in the next press nip (NP_1) (Fig. 4).

6. A method as claimed in any of the claims 1 to 3, **characterized** in that on said transfer-belt loop (20) the web is passed directly into the first press zone (N_1,NP_1) proper in the press section, placed after the pre-press zone (PN;PN_1,PN_2), through which press zone, besides said transfer belt (20), also a press fabric (25) substantially receiving water is passed, so that the dewatering in said first press zone proper takes place primarily into said first water-receiving press fabric (25), preferably downwards.

7. A method as claimed in any of the claims 1 to 6, **characterized** in that after the first press zone (N_1) proper the web is transferred on said transfer belt (20) onto the press fabric of the next dewatering press zone, preferably onto a lower fabric (35) that receives water.

8. A method as claimed in any of the claims 1 to 7, **characterized** in that, in connection with the forming wire (10;10A), two successive pre-press zones (PN_1, PN_2; $PN0_0$,PN; PN_{01},PN) are arranged, of which zones said transfer belt (20) is passed at least through the latter zone so that at least in the latter pre-press zone (PN,PN_2) the dewatering takes place exclusively or primarily through the forming wire (10;10A) in one direction, preferably downwards, and that, after said latter press zone (PN,PN_2), the web is substantially immediately separated from the forming wire (10;10A) and transferred on said transfer belt (20) as a closed draw through the next press zone in the press section or onto the press fabric (25) passing into said zone.

9. A method as claimed in claim 8, **characterized** in that the web is passed on the forming wire (10;10A) first into such a first pre-press zone (PN_{00}) through which, besides the forming wire (10;10A), also a pre-press wire (10C) is passed, after which the web (W_1) that was pre-pressed in said zone (PN_{00}) is passed on the forming wire (10;10A) into the following, latter pre-press zone (PN) (Fig. 7).

10. A method as claimed in claim 8, **characterized** in that the paper web (W_0) that has been formed on the forming wire (10;10A) is passed into the first pre-press zone (PN_{01}), which is formed between an upper smooth-faced (21a) press roll (21A) and a lower open-faced (22a) press roll (22), a second press zone (PN) being also formed in connection with the latter roll (22), through which second press zone (PN) said transfer-belt loop (20) is passed (Fig. 8).

11. A method as claimed in claim 8, **characterized** in that inside the loop of the forming wire (10;10A), an open-faced (22a) press roll (22) is fitted, in connection with which two successive pre-press zones (PN_1,PN_2) are formed, said transfer-belt loop being passed through both of said pre-press zones (Fig. 9).

12. A method as claimed in any of the claims 1 to 11, **characterized** in that said transfer-belt loop (20A) is passed before the pre-press zone (PN) over the suction zone or zones (22aa,22bb) of the wire suction roll (22) of the forming wire, and by means of the tightening tension T of the transfer belt (20A) a tightening pressure $P = T/R$ [R = radius of the wire suction roll (22)] is produced on said suction sector or sectors, and in connection with the same wire suction roll (22) a transfer and pre-press nip zone (PN) is formed with the backup roll (21) (Figs. 10 and 11).

13. A press section in a paper or board machine, comprising a number of successive press zones, the paper web being transferred into the first one of said press zones as a closed draw from the forming wire (10,10A) of the paper machine, and the paper web to be pressed being transferred between the different zones in said press section as a supported and closed draw, and the paper web being transferred, after the last press zone of said press zones, to the dryer section of the paper machine as

a closed draw and a board web being transferred as a closed draw or as an open draw (W_F), **characterized** in that the press section includes a pre-press zone or zones (PN,PN_0; PN_{10}; PN_1,PN_2; PN_{00},PN; PN_{01},PN; PT,PN), that the press section includes a transfer-belt loop (20;20A;20B), which does substantially not receive water and whose outer face is capable of adhesion to the paper web, that said transfer-belt loop (20;20A;20B) is passed through said pre-press zone or, out of two zones, at least through the latter zone, that in said pre-press zone the paper web is made to adhere to the outside face of the transfer-belt loop (20;20A;20B) and, after said zone, is separated substantially immediately from the forming wire (10;10A) or equivalent (10W) without substantial rewetting of the web, and that, on said transfer belt (20;20A;20B), the web is passed as a closed and supported draw onto the next press fabric (25) in the press section and/or through the next press zone (N_1,N_2).

14. A press section as claimed in claim 13, **characterized** in that said pre-press zone (PN) is formed by a transfer and pre-press nip which has been arranged in connection with the forming wire (10;10A) and which dewaters the web to a substantially extent and in which the dewatering has been arranged to take place in the direction of the forming wire (10;10A) through the forming wire, preferably downwards, and that said transfer belt (20;20A;20B) is passed through said press zone (PN), on which belt the web is transferred onto the next press fabric (25) in the press section and/or through the next press zone (N_1;NP_1).

15. A press section as claimed in claim 13 or 14, **characterized** in that, in connection with the forming wire (10;10A), an extended-nip zone (PN) has been arranged as a pre-press zone, which extended-nip zone (PN) is formed by an open-faced (22a) roll (22) placed inside the loop of the forming wire (10;10A) and by a shoe press (23B) placed inside the loop of the transfer belt (20), and that the paper web (W) is carried on said transfer belt (20) to the next pressing stage, preferably into an extended-nip press (NP_1) (Fig. 12).

16. A press section as claimed in any of the claims 13 to 15, **characterized** in that, after the pre-press zone (PN), the press section includes at least two nip zones

(N_1,NP_2; NP_1,NP_2), of which at least one, preferably the latter one (NP_2), is an extended nip.

17. A press section as claimed in any of the claims 13 to 16, **characterized** in that, in connection with the forming wire (10;10A), a web adhering nip (PN_0) of relatively low loading has been arranged, in which nip the upper fabric is said transfer belt (20), on which the paper web is passed into a first pre-press zone (NP) separate from the former section, in which zone (NP) the lower fabric is a pre-press wire (25W) of relatively open and permeable fabric structure, and that after said pre-press zone (PN) the web is passed on said transfer belt (20) onto the lower press fabric (35) of the next press zone (NP_1) (Fig. 3).

18. A press section as claimed in any of the claims 13 to 17, **characterized** in that the paper web is passed from the forming wire (10) onto the pre-press wire (10W) on the suction zone (24a) of the pick-up suction roll (24), and that on said pre-press wire (10W) the web is transferred into a pre-press zone (PN_{10}) separate from the former section, in which zone the lower fabric is the transfer belt (20B), on which the web is transferred as a closed draw onto the upper press fabric (30) of the next press zone (NP_1) (Fig. 4).

19. A press section as claimed in any of the claims 13 to 18, **characterized** in that, in connection with the forming wire (10A), two successive pre-press zones (PN_1,PN_2; PN_{00},PN; PN_{01},PN; PT,PN) have been arranged, said transfer belt (20) substantially not receiving water being passed at least through the latter one of said pre-press zones.

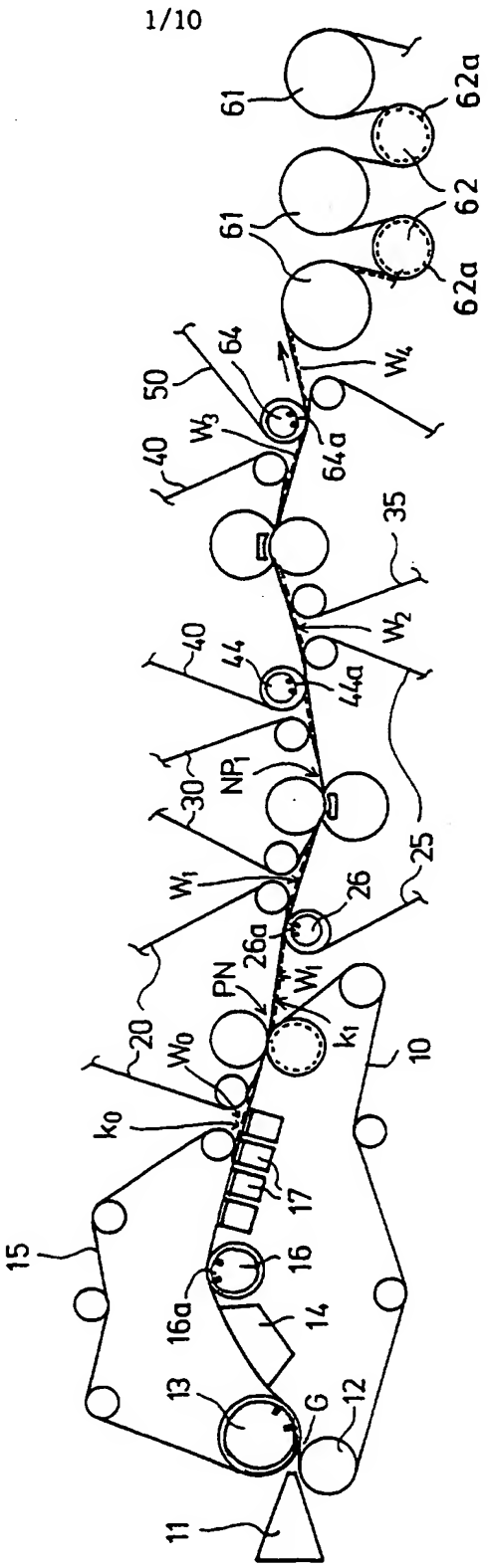
20. A press section as claimed in claim 19, **characterized** in that the press section includes such a first pre-press zone (PN_{00}) arranged in connection with the forming wire (10;10A) through which a pre-press wire (10C) of its own is passed, and that in connection with the forming wire (10;10A) there is a latter pre-press zone (PN), through which said transfer belt (20) is passed (Fig. 7).

21. A press section as claimed in claim 19, **characterized** in that the press section includes such a first pre-press zone (PN_{01}) fitted in connection with the forming wire (10;10A) as has been formed between an open-faced (22a) press roll (22), placed inside the forming-wire loop (10;10A), and an upper smooth-faced (21a) press roll (21A), after which, in connection with said press roll (22), a second, latter pre-press zone (PN) has been formed, said transfer belt (20) being arranged to run through said latter pre-press zone (Fig. 8).

22. A press section as claimed in claim 21, **characterized** in that said open-faced (22a) press roll (22) is a suction roll, whose suction zone extends substantially over the area of said first pre-press zone (PN_{01}) only.

23. A press section as claimed in any of the claims 13 to 22, **characterized** in that in connection with the suction zone or zones (22aa,22bb) of the wire suction roll (22) of the forming wire (10;10A), a pre-press zone (PT) has been arranged, which has been produced by means of the tightening tension (T) of the transfer belt (20A), and that in connection with said wire suction roll (22), after said pre-press zone (PT), there is a pre-press nip zone (PN) proper, after which the web is passed on said transfer belt (20A) as a closed draw to the press section (Figs. 10 and 11).

24. A press section as claimed in any of the claims 13 to 23, **characterized** in that the paper web is passed through said pre-press zone (PN) and through the following at least two press zones (NP_1,NP_2) as a closed and supported draw along such a relatively linear path in which the angle of change in direction is $d < 30°$, and that the paper web is passed from the last press zone (NP_2) in the press section on the lower or upper fabric of said zone onto the drying wire (60) of the first group of cylinders (61,62) in the dryer section of the paper machine, preferably as a closed draw (Fig. 1).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62a
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61
62a
64
50
W4
W3
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40
35
W2
40
44
44a
NP1
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W1
26
26a
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k0
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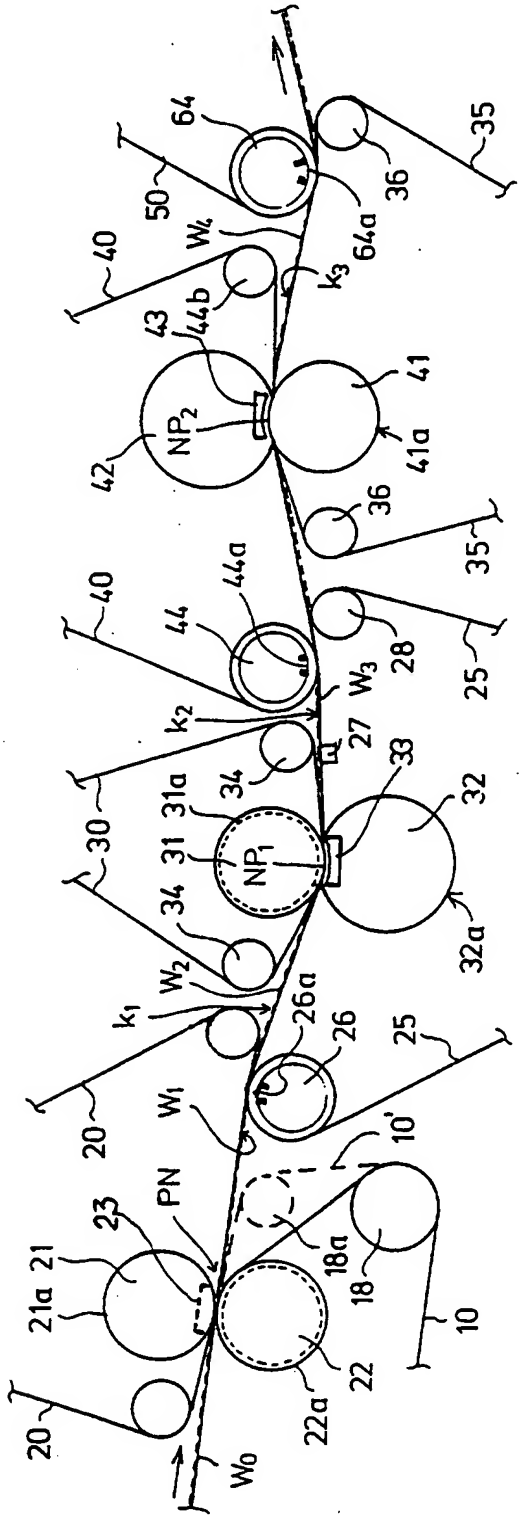
15
16
16a
14
13
G
12
11

FIG.1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W4
64a
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35
k3
43
44b
41
NP2
42
41a
36
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40
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44a
28
25
W3
k2
27
33
34
31a
32
30
31
NP1
34
32a
W2
k1
26a
25
26
20
W1
10'
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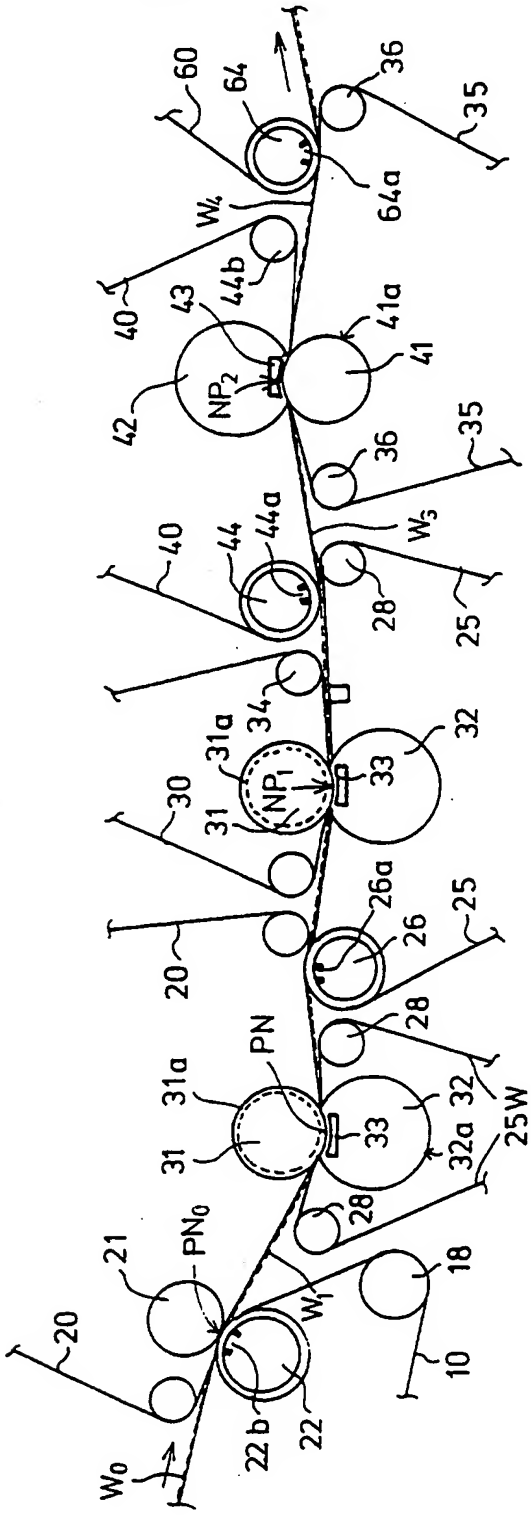
21
21a
18
10
22
20
22a
W0

FIG. 2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35
64a
W_4
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43
44b
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41
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NP_2
36
35
W_3
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44
44a
28
25
34
31a
32
NP_1
33
30
31
26a
25
20
26
28
PN
31a
32
31
33
32a
25W
28
21
PN_0
18
W_1
20
10
22b
22
W_0

FIG. 3

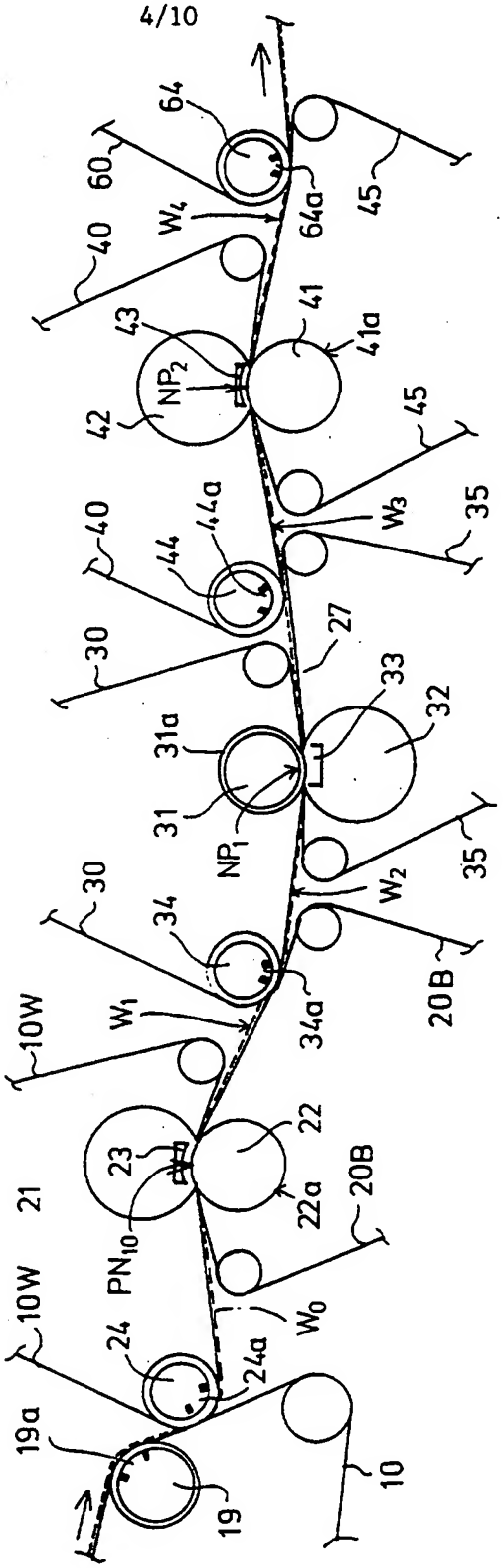
64
60
40
W4
64a
45
43
NP2
41
41a
42
45
W3
35
40
44
44a
30
27
31a
33
32
31
NP1
W2
35
30
34
34a
20B
10W
W1
22
23
21
22a
20B
10W
PN10
24
W0
24a
19a
19
10

FIG. 4

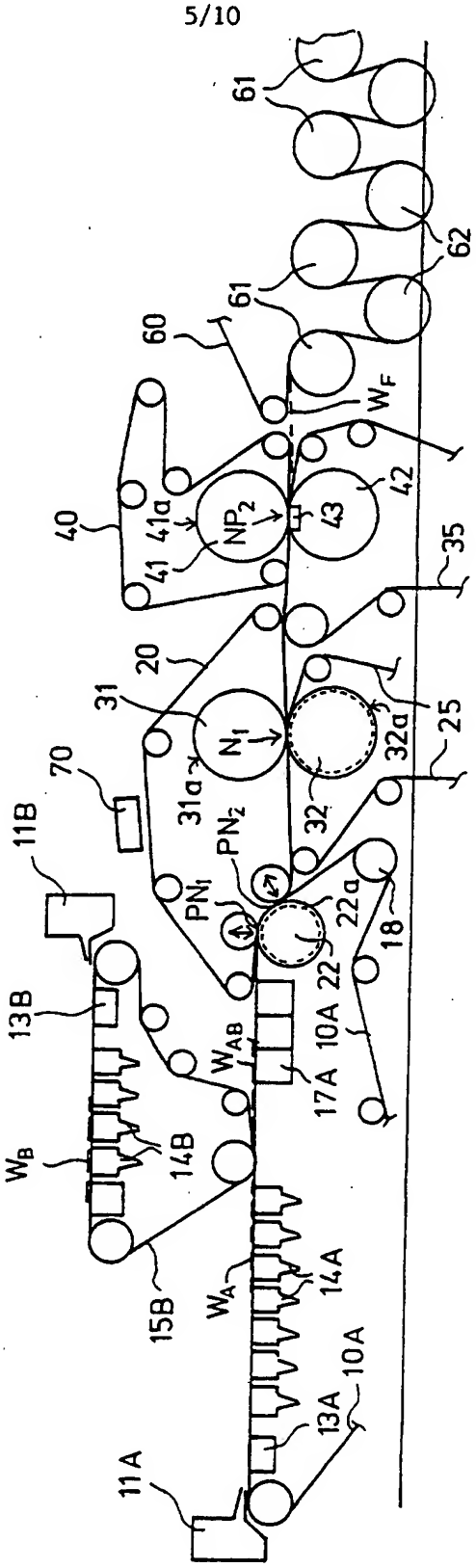
61
62
61
60
W_F
40
41a
NP_2
43
42
41
35
20
31
N_1
32a
25
70
31a
PN_2
32
11B
PN_1
22a
18
13B
22
10A
W_{AB}
17A
W_B
14B
15B
W_A
14A
10A
13A
11A

FIG.5

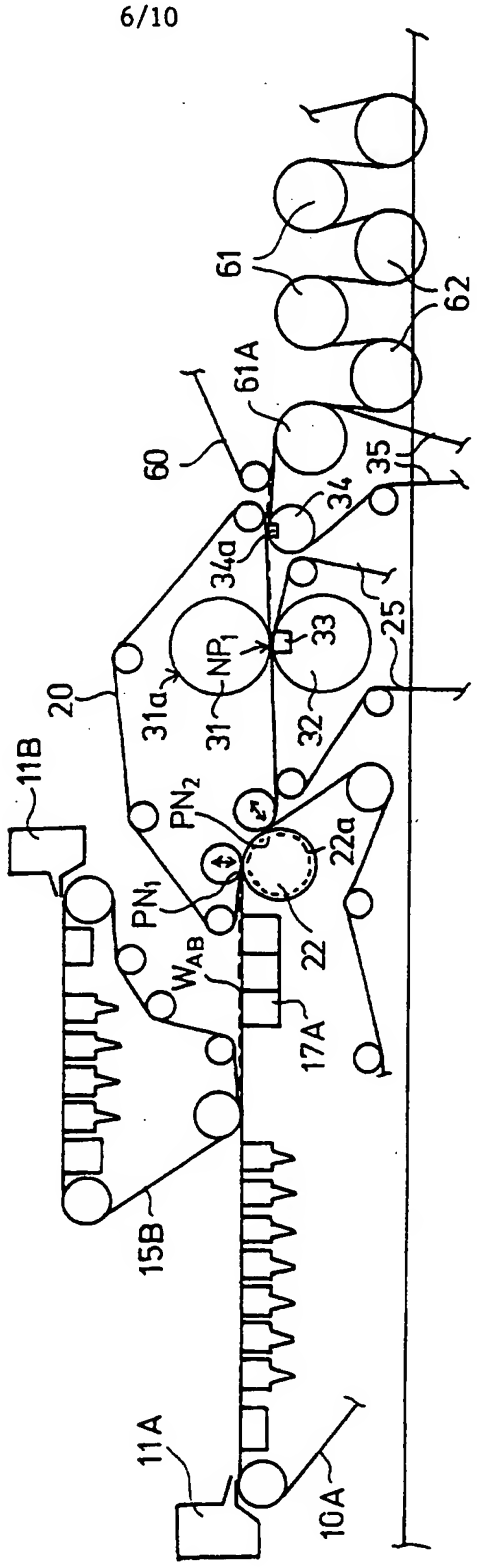
1
61
62
61A
60
35
34
34a
33
25
NP1
31a
31
32
20
11B
PN2
PN1
22a
22
WAB
17A
15B
11A
10A

FIG. 6

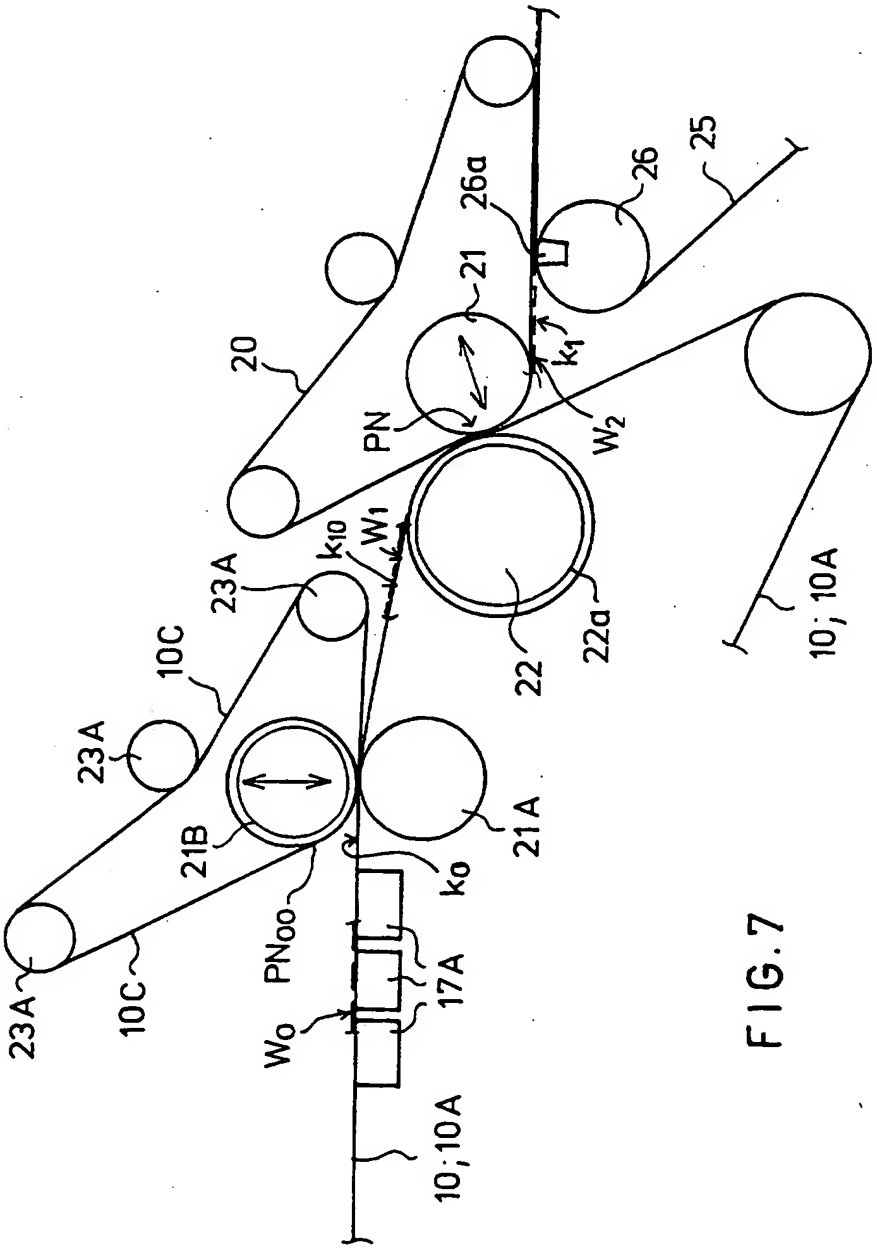
23A
10C
23A
10C
21B
PN_{oo}
W_o
17A
k_o
21A
22
22a
23A
k_{10}
W_1
20
PN
21
26a
k_1
W_2
26
25
10; 10A
10; 10A

FIG. 7

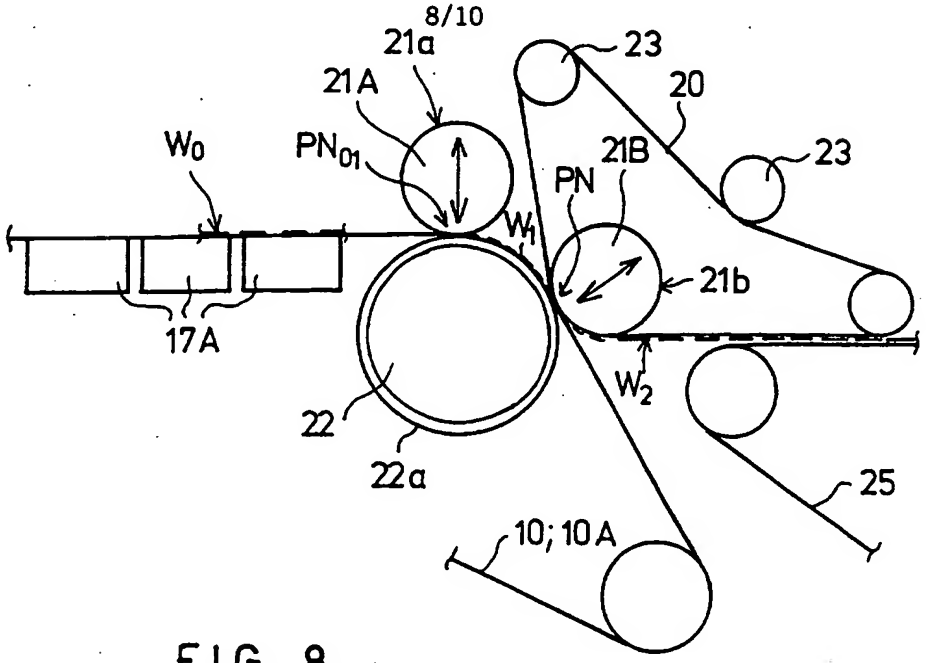
21a
21A
23
20
W_0
PN_{01}
21B
PN
23
W_1
21b
17A
W_2
22
22a
25
10; 10A

FIG. 8

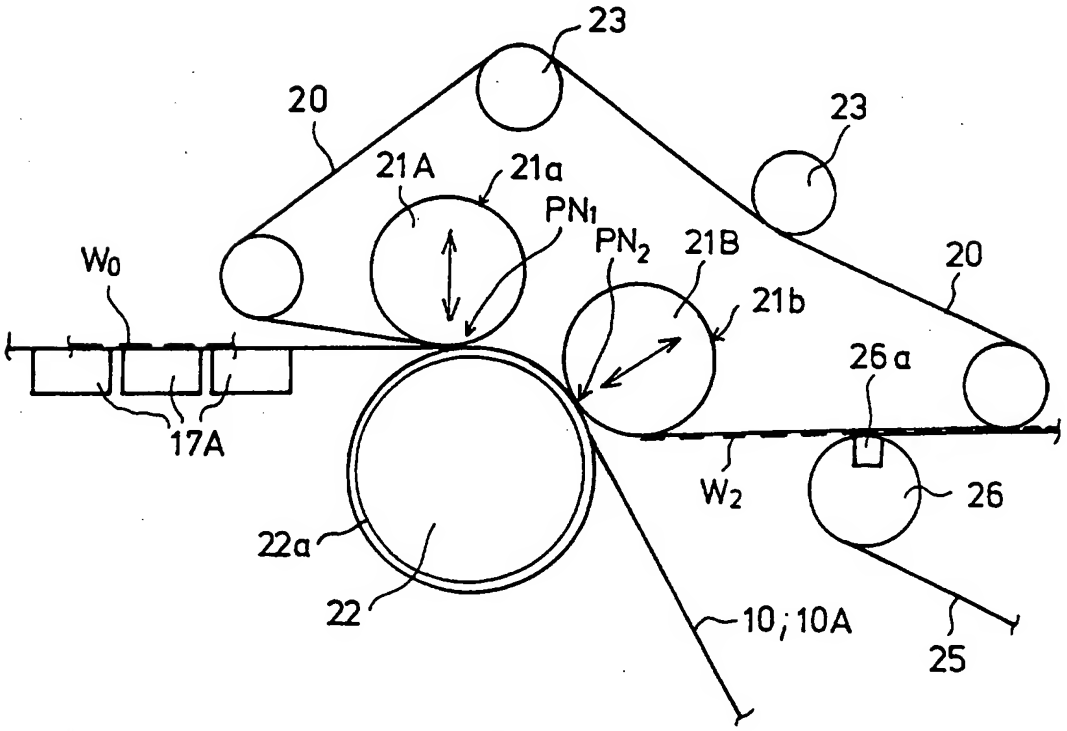
23
20
23
21A
21a
PN_1
PN_2
21B
W_0
20
21b
26a
17A
W_2
26
22a
22
10; 10A
25

FIG. 9

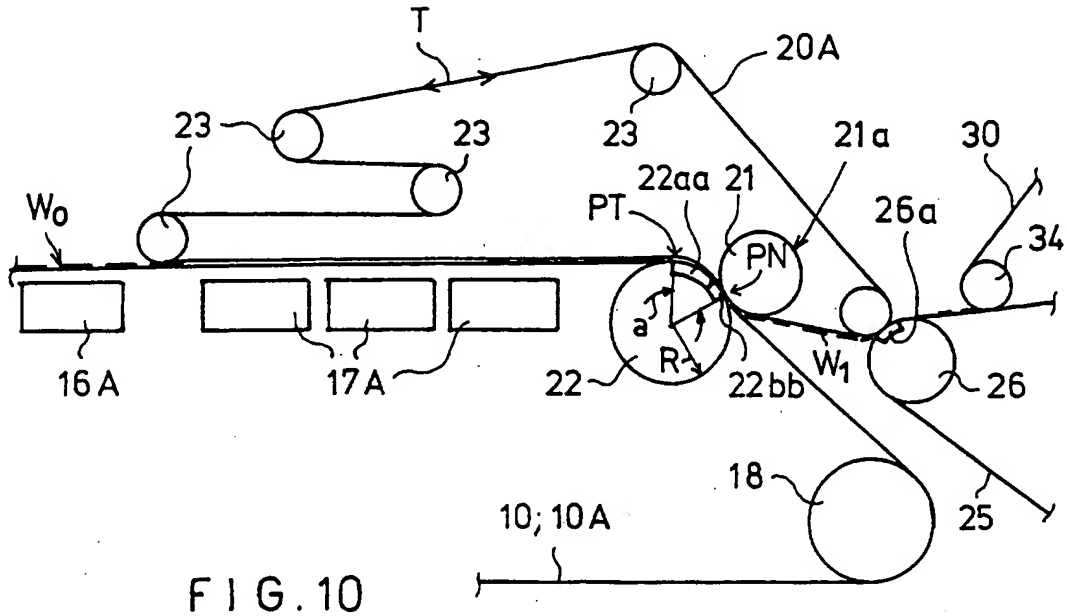
T
20A
23
23
23
21a
30
W_o
22aa
21
PT
26a
34
PN
a
R
16A
17A
22
22bb
W_1
26
18
25
10;10A

FIG. 10

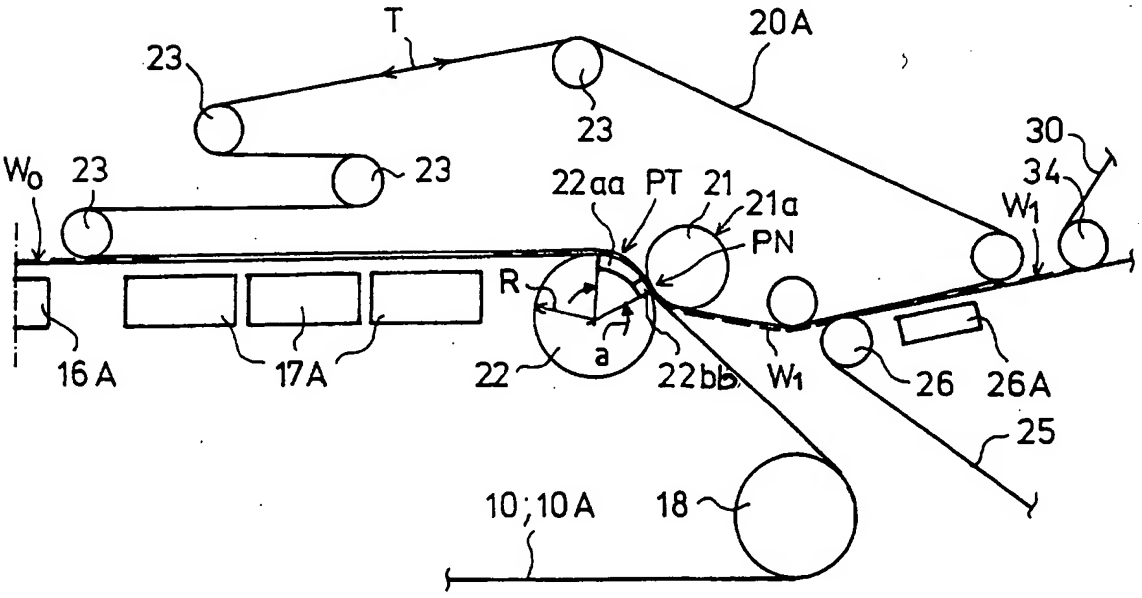
T
20A
23
23
23
30
34
W_o
23
22aa
PT
21
21a
W_1
PN
R
a
16A
17A
22
22bb
W_1
26
26A
25
10;10A
18

FIG. 11

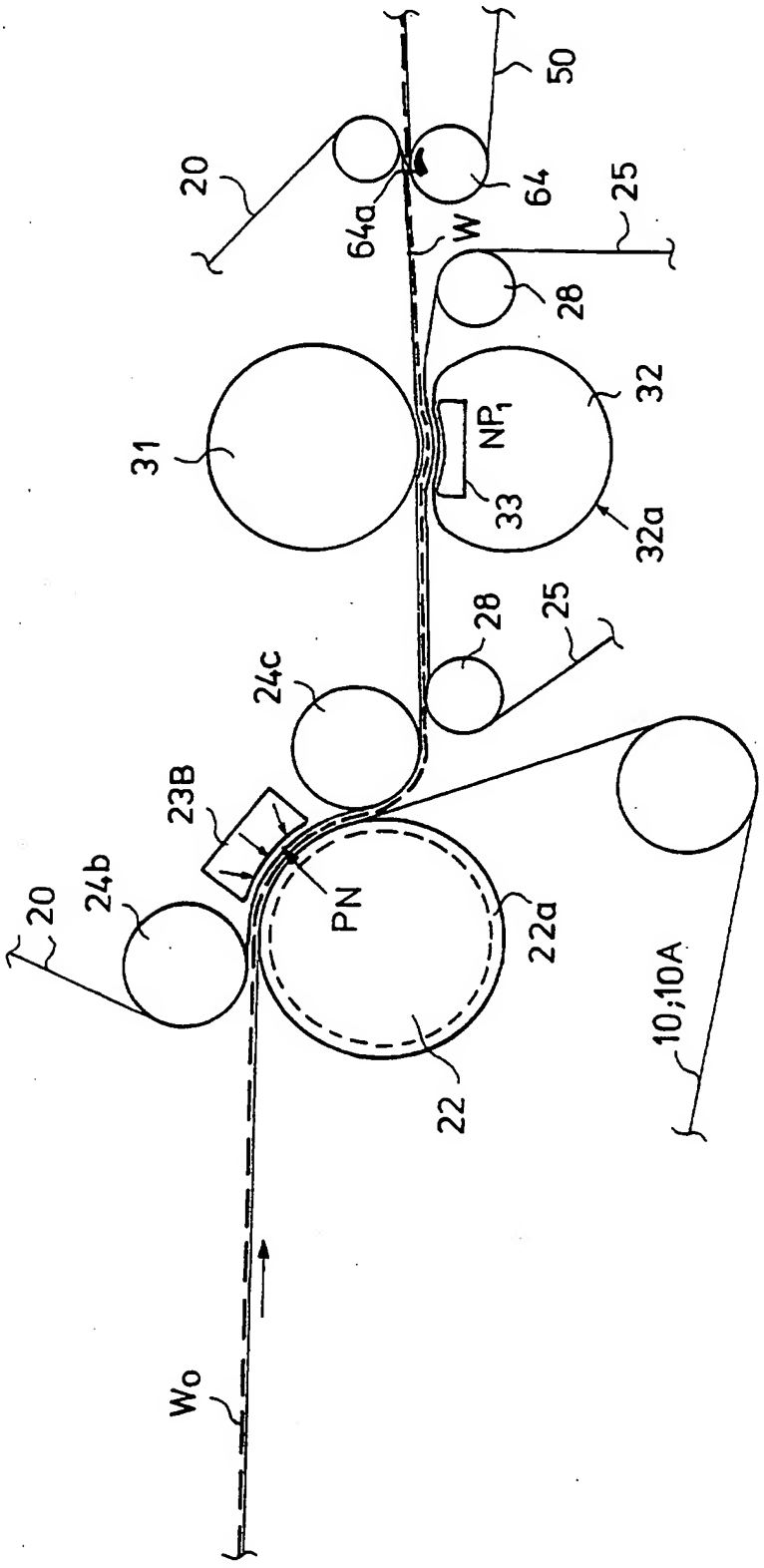
50
20
64a
64
25
W
28
32
31
NP1
33
32a
28
25
24c
23B
20
24b
PN
22a
10;10A
22
Wo

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 96/00496

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: D21F 3/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5389205 A (JUHANI PAJULA ET AL), 14 February 1995 (14.02.95), column 3, line 28 - line 42; column 8, line 7 - line 51, figure 2, claims 4,5	1,13
A	--	2-12,13-24

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 January 1997	17 -01- 1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Olov Jensén Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/10/96

International application No.
PCT/FI 96/00496

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 5389205	14/02/95	CA-A- 2055927	24/05/92
		EP-A- 0487483	27/05/92
		FI-B,C- 96789	15/05/96